BARYON CYCLES SWG: TECHNOLOGY DRIVERS

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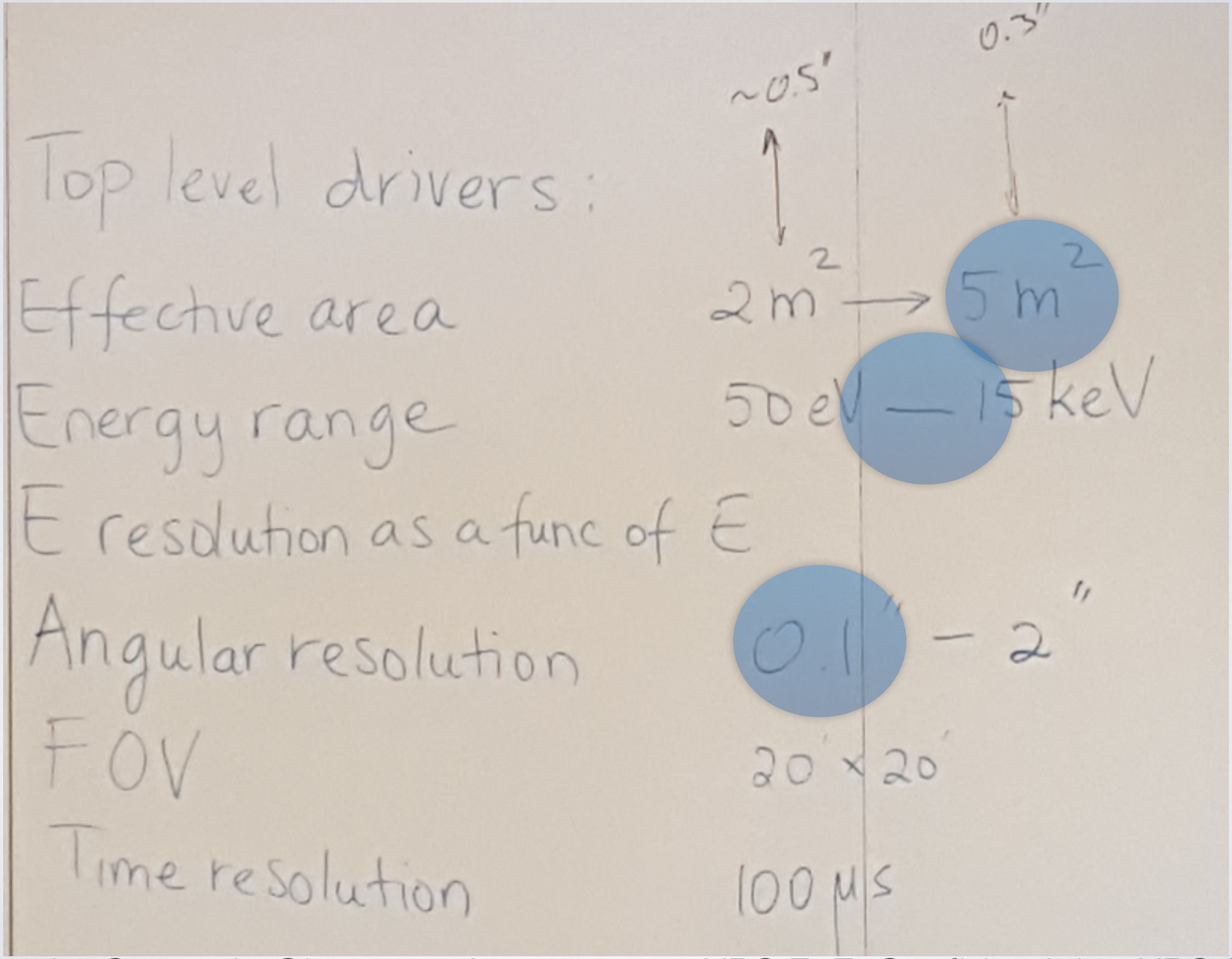
BOUNDARY CONDITIONS



Science Drivers

- Mapping the Circumgalactic Media of galaxies (emission/absorption)
- Growth and accretion history of Clusters and Galaxy Groups
- Cosmic census of baryons and metals

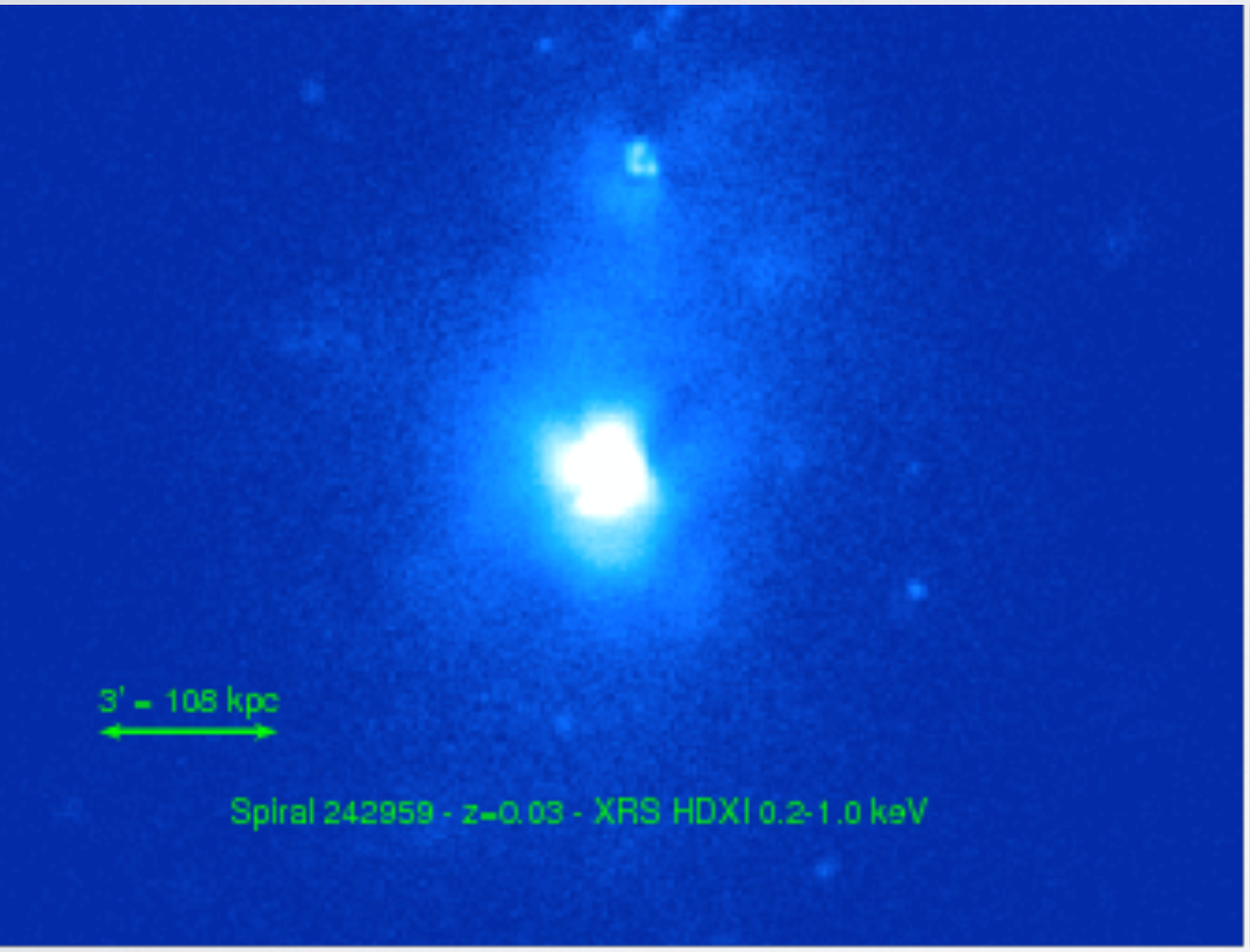
XRS as Filament Mapper

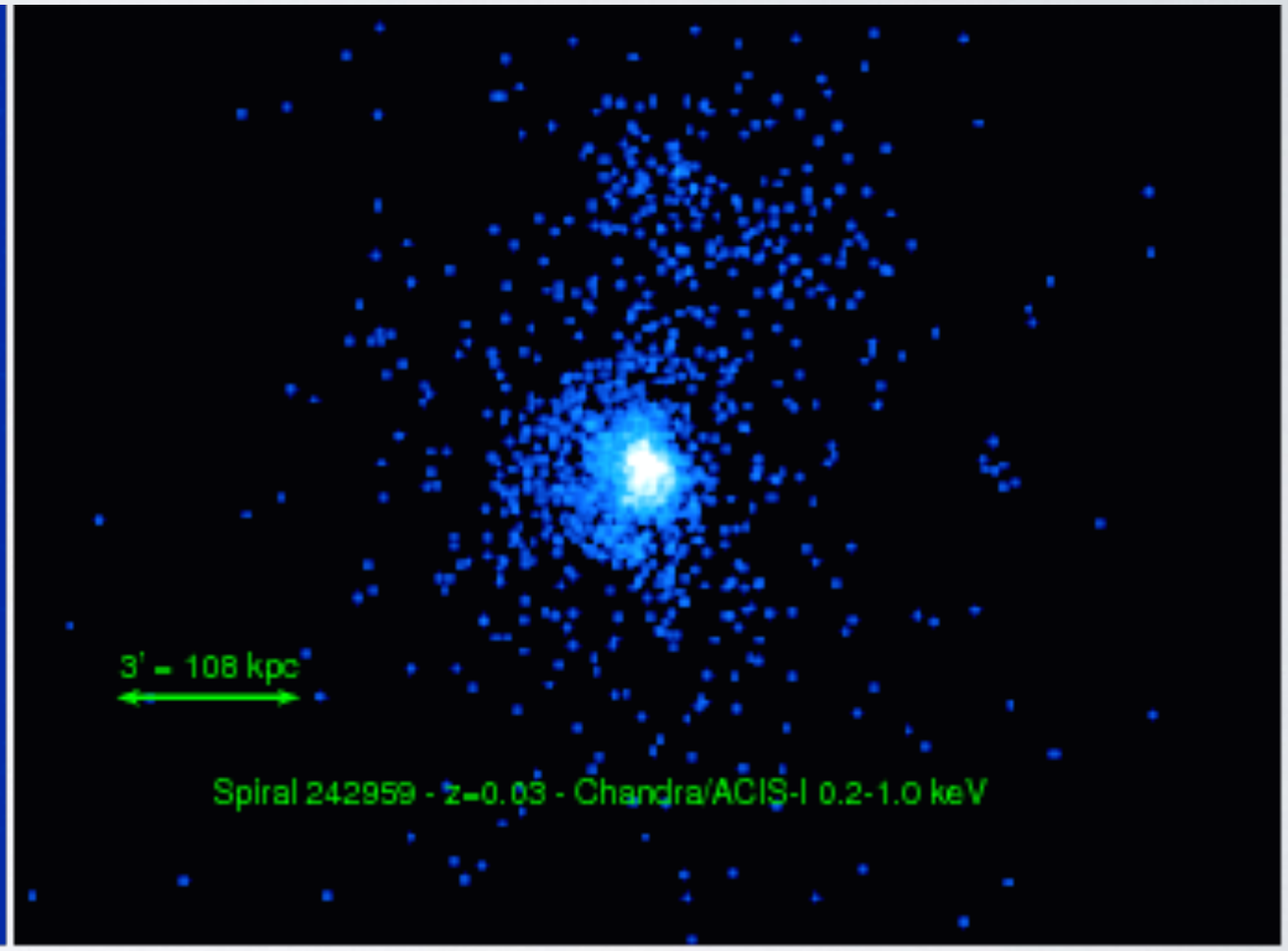
- Emissivity of filaments allows determination of metallicity
- Ability to remove point sources crucial for low surface brightness material
- Does the WHIM* exist in the form predicted by galaxy formation theory?
    - Baryon fraction, especially in clusters at R>Rvir
    - Temperature structure
    - Geometry
    - Abundance and distribution of metals
    - Evolution with redshift (probably limited to z < 1)
- What does the “Cosmic Web” look like in emission and absorption?
    - absorption line studies require high energy resolution
    - emission studies require high sensitivity

X-ray Emissivity

- Primary driver for emission mapping is sensitivity
- Effective area and spatial resolution key
- No obvious upper threshold —- bigger is better
- WG Recommendation: Hold firm on baseline design. Soft response (to 2Kev) critical for our science goals

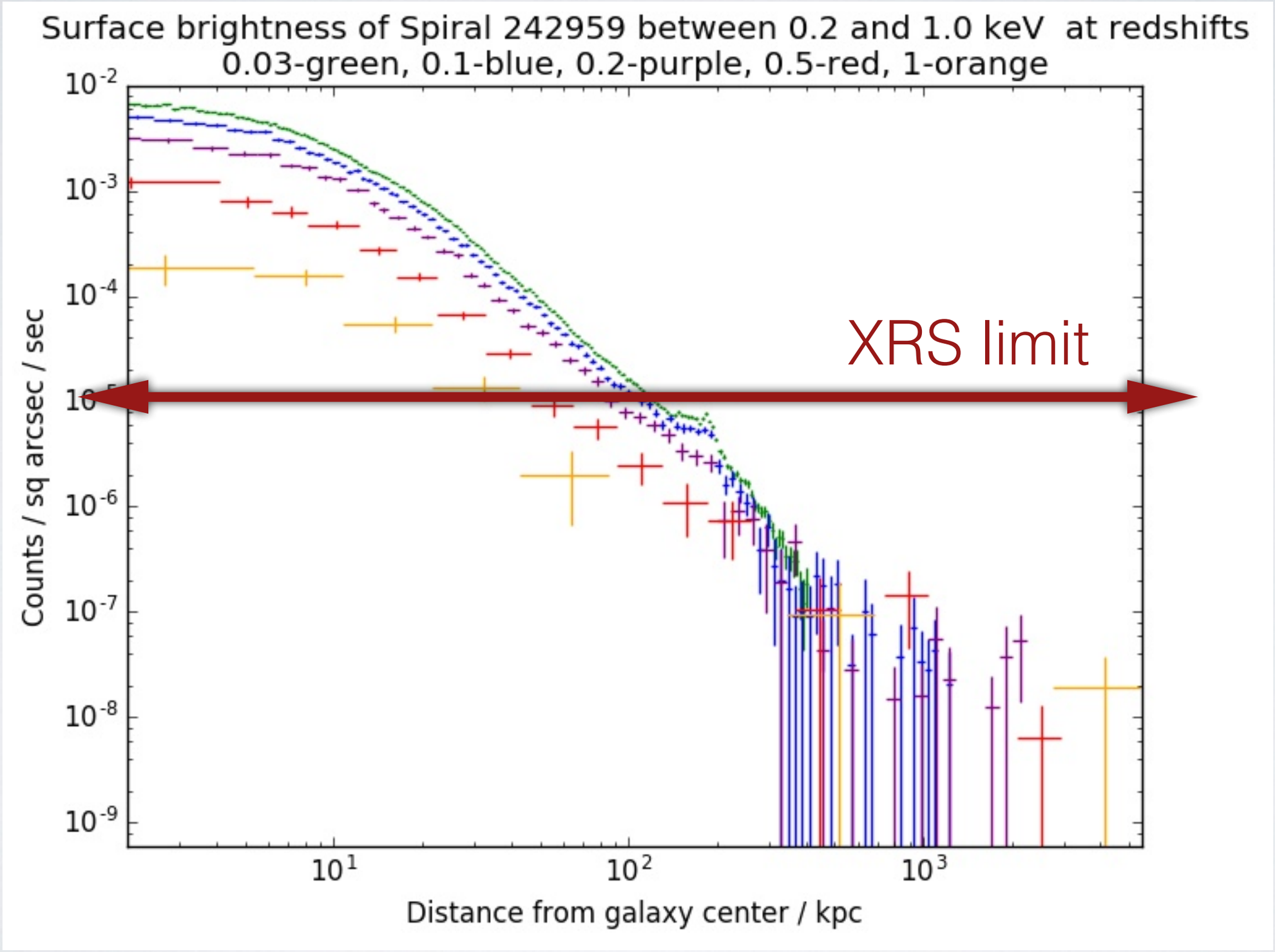
BASELINE XRS = MAJOR LEAP FORWARD





From R. Kraft, A. Bogdan, S. Nulsen, J. ZuHone

MAPPING GALACTIC OUTSKIRTS



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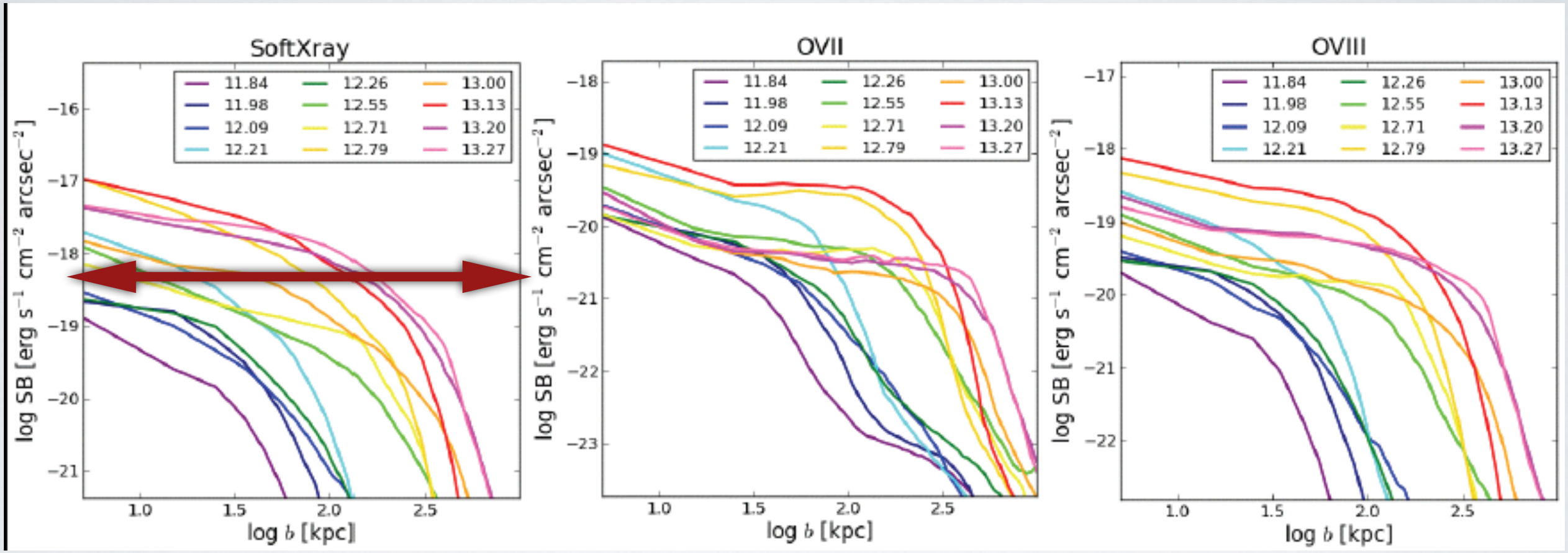
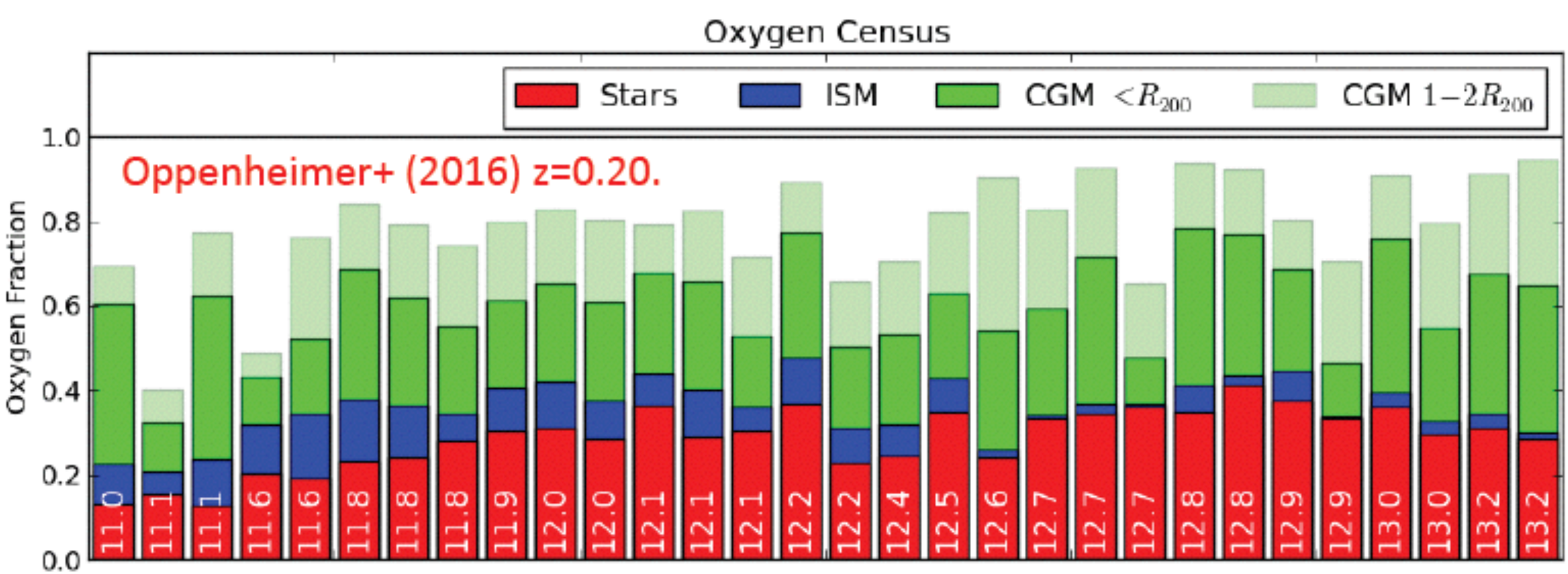
MAPPING GALACTIC OUTSKIRTS

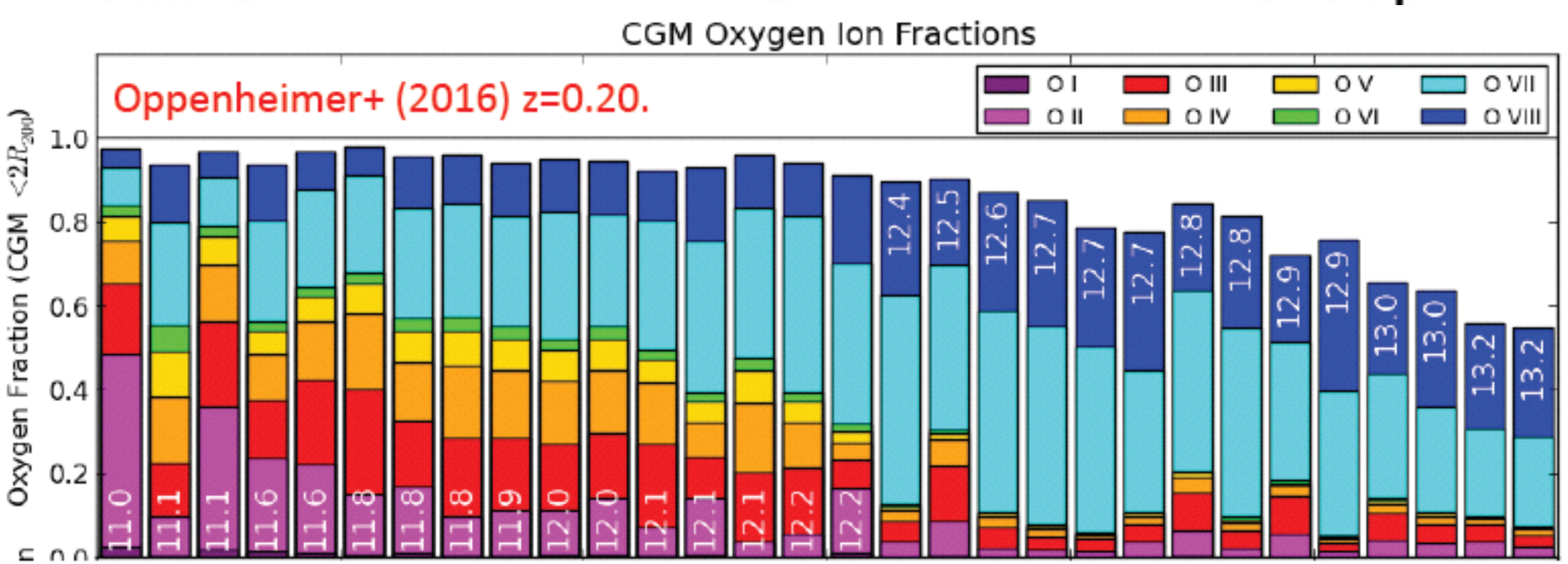
Mass and redshift dependence



From B.Oppenheimer, R. Crain, J. Schaye (EAGLE)


Oxygen Census
Stars
ISM
CGM $<R_{200}$
CGM $1-2R_{200}$
Oppenheimer+ (2016) z=0.20.
Oxygen Fraction
1.0
0.8
0.6
0.4
0.2
0.0
11.0
11.1
11.1
11.6
11.6
11.8
11.8
11.8
11.9
12.0
12.0
12.1
12.1
12.1
12.2
12.2
12.4
12.5
12.6
12.7
12.7
12.7
12.8
12.8
12.9
12.9
13.0
13.0
13.2
13.2

Sub-L* --> L* --> Group


CGM Oxygen Ion Fractions
Oppenheimer+ (2016) z=0.20.
O I
O II
O III
O IV
O V
O VI
O VII
O VIII
Oxygen Fraction (CGM $<2R_{200}$)
1.0
0.8
0.6
0.4
0.2
11.0
11.1
11.1
11.6
11.6
11.8
11.8
11.8
11.9
12.0
12.0
12.1
12.1
12.1
12.2
12.2
12.4
12.5
12.6
12.7
12.7
12.7
12.8
12.8
12.9
12.9
13.0
13.0
13.2
13.2

X-ray emissivity maps of gaseous halos of simulations with different star formation parameters and feedback strength

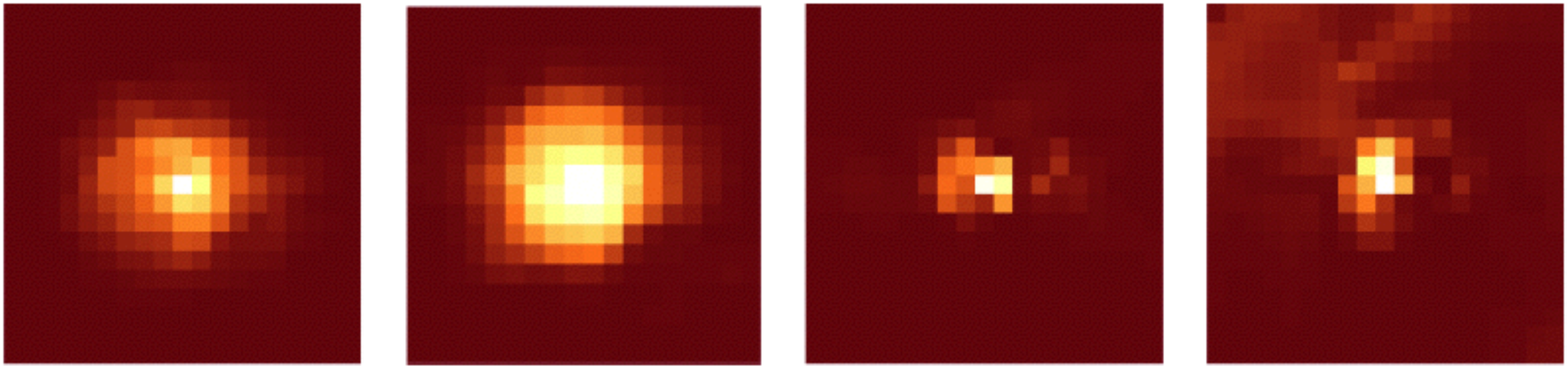
From A. Kravtsov, O. Agertz (ART)

Gaseous halos are taken at z=1.5 (similar differences expected at lower z)

Scales and color maps matched. Brightness corresponds to observed X-surveyor counts in the 0.2-1 keV band (observer frame). Pixel is 0.5 arcsec (~X-surveyor angular resolution = 4.1kpc physical)

moderate feedback + high sf efficiency (strong outflows)	*moderate feedback + low sf efficiency (weak outflows)*	*strong feedback + low sf efficiency (strong outflows)*	*moderate feedback + high sf efficiency + cosmic rays (strong outflows)*

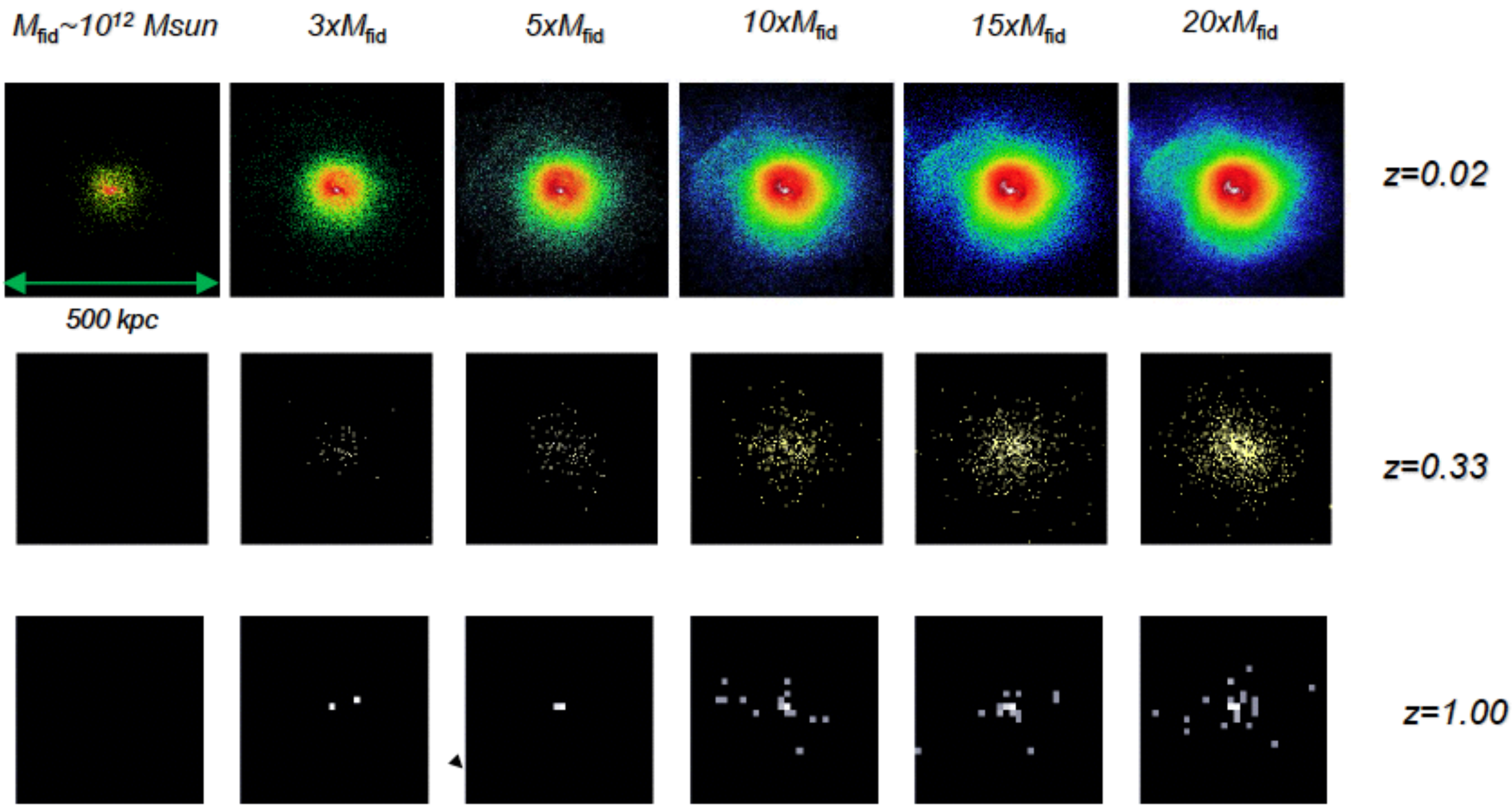
ratio of counts in these models is 0.15 : 0.91 : 0.09 : 0.83



X-ray surveyor maps of gaseous halos of the fiducial simulation scaled to different masses

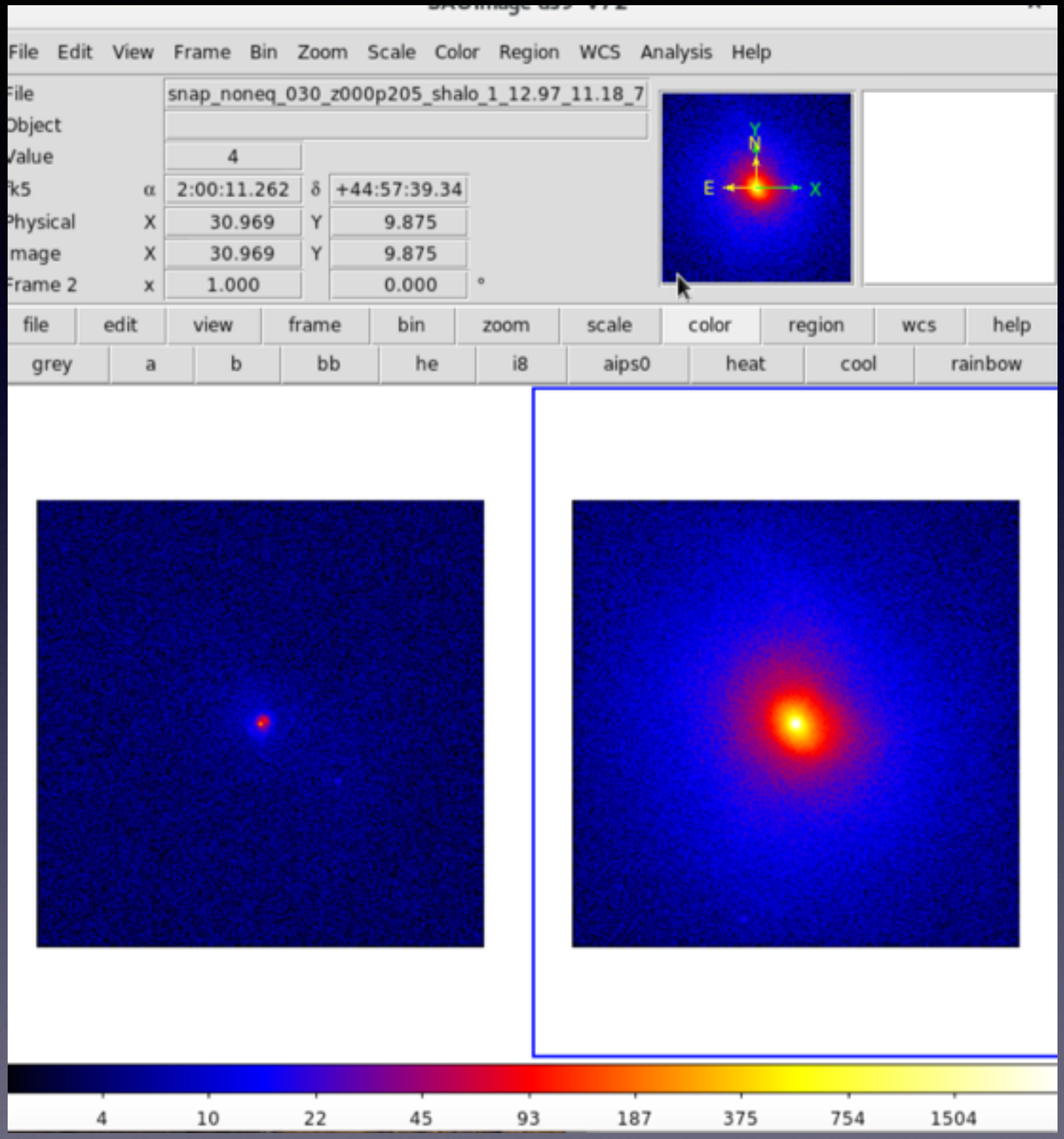
From A. Kravtsov, O. Agertz (ART)

X-ray counts shown are in the 0.2-1 keV band (observer frame) for 100 ksec exposure.
Pixel size is 4arcsec for z=0.02, and 0.5 arc sec for z=0.33 and 1.0



From B.Oppenheimer, R. Crain, J. Schaye (EAGLE)

- Thanks to J. ZuHone's SOXS, we are making event files
- Example here shows effect of AGN feedback as implemented in EAGLE
- Huge effects —> XRS will constrain these
- Observers will be analyzing these event files (observing the mock observations)



X-ray Absorption

- Still working on generating synthetic spectra
- Column density maps from Eagle runs in hand
- Empirical results (Chandra/XMM) offer some guidance indicating XRS —> transformative
- No specific recommendations at this point

ABSORPTION MAPS

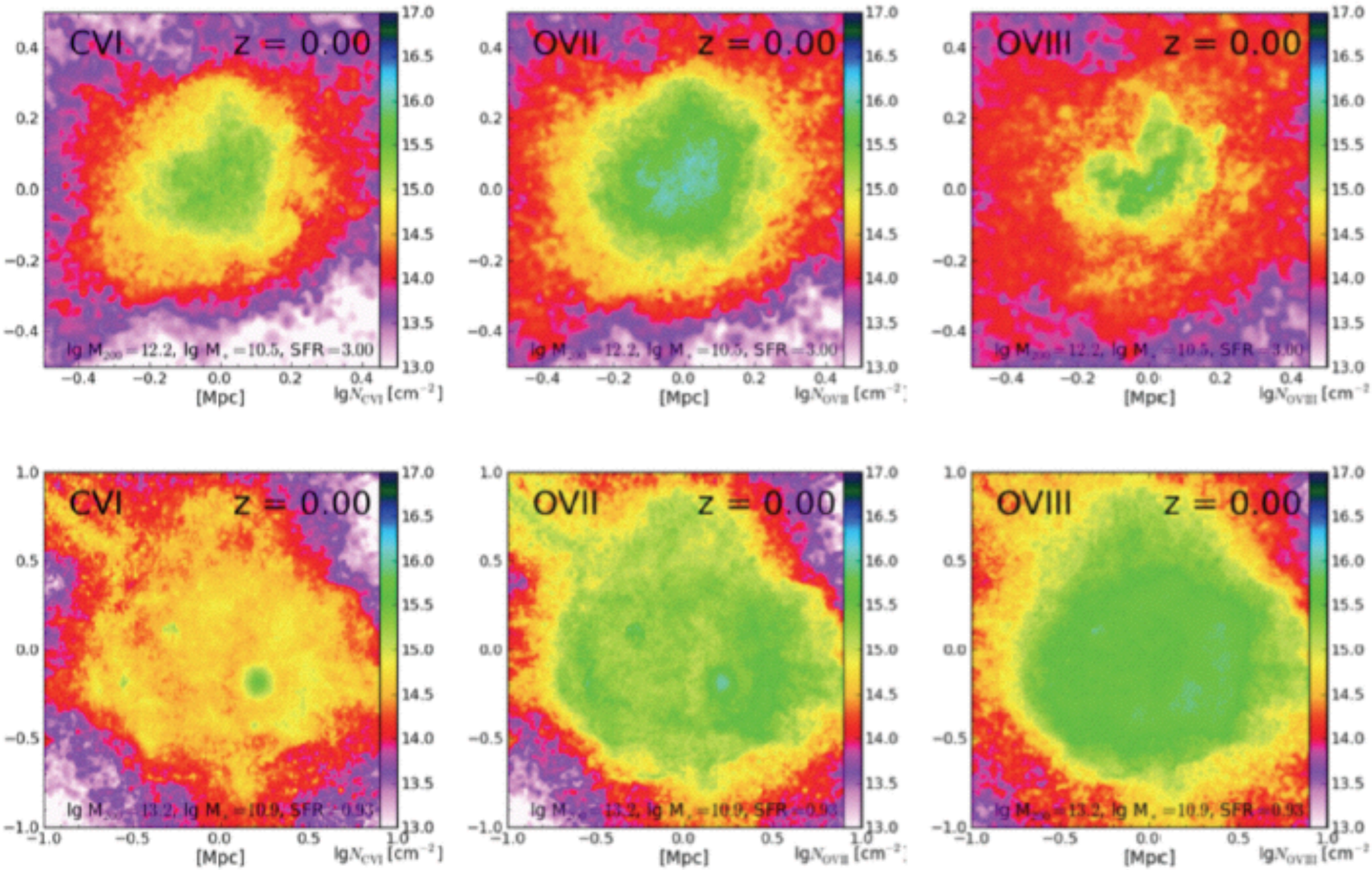


Figure 1. EAGLE zoom simulations run to $z = 0.0$ showing column densities of X-ray ions around a star-forming galaxy in a $10^{12.2}$M$_\odot$ halo (top panels, 1 × 1 Mpc frames) and an elliptical galaxy in a $10^{13.2}$M$_\odot$ halo (bottom panels, 2 × 2 Mpc frames). C VI, O VII, and O VIII are shown from left to right.

From B.Oppenheimer, R. Crain, J. Schaye (EAGLE)